The ideal radiation detector does not exist however knowing the characteristics of each of the detectors available will allow us to choose the most appropriate for a particular dose measurement. During the last years due to the implementation of new techniques and technologies new detector systems have been commercialized in order to guarantee safe treatment delivery. This talk will review the physical principles of operation of different commercial detectors and how they can be used for reference and relative dose measurements in high energy x-ray beams. Point detectors such as ion chambers, diamonds, diodes, MOSFET and scintillators will be described focusing in their strengths and limitations. Considerations on when and how these detectors should be used will be given. I will also cover briefly 2D measurements using point detectors arrays and radiochromic films.

Teaching Lecture: Secondary cancer after RT: Measuring / estimating organ doses and models of prediction

SP-0197

Secondary cancer after RT: measuring / estimating organ doses and models of prediction

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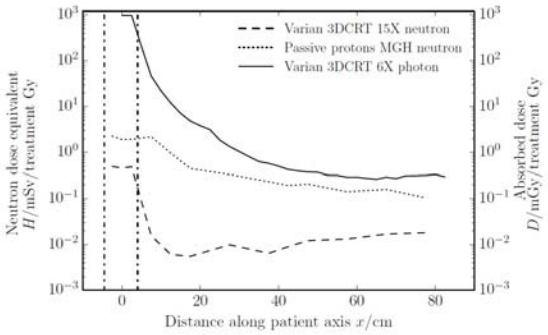
In developed countries more than half of all cancer patients receive radiotherapy at some stage in the management of their disease. However, a radiation induced secondary malignancy can be the price of success if the primary cancer is cured or at least controlled.
With the application of new radiation treatment modalities such as intensity modulated radiotherapy, intensity modulated arc-therapy, proton and heavy ion radiotherapy increased cancer cure rates are expected. However, with the application of these treatment techniques also a larger number of secondary cancers is expected. Some workers believe that we will see an increase in second malignancies due to the substantial increase in beam-on time of IMRT techniques to deliver the same target dose and the different distribution of dose ("low dose to a large volume") compared to conventional treatment techniques. In addition, during proton and heavy ion radiotherapy neutrons are created and could also have an impact on secondary cancer incidence. Therefore it could be of great importance to know the risk for the patient to develop a cancer which could have been caused by the radiation treatment.
The long term risks from modern radiotherapy treatment techniques have not yet been determined and are unlikely to become apparent for many years, due to the long latency time for solid tumor induction. Therefore there is a need to develop models for risk assessment based on the current knowledge of radiation induced carcinogenesis.
The current knowledge of the shape of the dose-response curve for radiation induced cancer for doses larger than a few Gy is reviewed. In patients who receive radiotherapy, parts of the patient volume can receive high doses of up to approximately 100 Gy and it is therefore of great importance to know the dose-response curve of the risk for the patient to develop a cancer which could have been caused by the radiation treatment. These dose-response curves are then used to model second cancer induction for radiotherapy patients based on the three-dimensional dose distribution of the treatment of the primary disease. Current models used for such risk estimates are reviewed.
The three-dimensional dose distributions including the peripheral dose on which the risk modeling is based on is reviewed for different linear accelerators and treatment techniques. In addition the neutron dose of photon and proton treatments is analysed. In the figure the neutron dose equivalent of passive proton therapy (dotted line) is plotted as a function of the distance from the isocenter for a adolescent patient who was treated for a rabdomyosarcoma in the prostate. In comparison the photon scatter dose for a 3DCRT 6 MV treatment plan (solid line) and the neutron dose equivalent of 3DCRT 15 MV (dashed line) therapy is plotted.



Teaching Lecture: Current overview of radiotherapy for breast cancer

SP-0198

Current overview of radiotherapy for breast cancer

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Technological advances combined with increasing knowledge about the natural course of malignant diseases progressed enormously over the last decades. Improved RT-techniques were, remarkably, only relatively late introduced for treatment of malignant lymphoma and breast cancer, two disease sites where excellent results with a high cure rate and thereby a high demand to avoid long term toxicity are obtained. Especially in breast cancer, still today some departments do not properly delineate target volumes and/or continue to use rather basic RT-techniques.
ESTRO published a consensus guideline for target volume delineation in breast cancer that was developed in five years of work, after obtaining a broad consensus agreement of the RT-community. The next step is now to introduce volume contouring in agreement with these guidelines on a routine base. Personal experience is that, after proper training, it can be done in a very reliable and little time consuming manner. It could also be appropriate to involve, to train and involve RTT for doing this under the responsibility of the radiation oncologist. The downloadable as well as online available fully contoured cases will greatly facilitate this.
Many RT-techniques have been described and are in use, often based on older standard techniques that are adapted and optimized to improve dose homogeneity, treatment positioning or treatment time, while others are based on new technical developments. For sure, the optimal technique for all patients does simply not exist and the most appropriate setup should be chosen based on a combination of the

patient's anatomy and the target volumes to be irradiated, and further individualized after balancing possible benefits and risks that can be anticipated based on the outcome of treatment planning. Therefore, in agreement with the "Pareto principle", it is advisable to choose one basic treatment technique for the department that is most appropriate for 80% of the cases and select out of different other treatment setups in a highly individualized manner for the remaining 20% for which the basic treatment setup might not be optimal.
In the meantime, our knowledge about breast cancer and its' treatment continues to increase, leading to changing attitudes towards the selection of the most appropriate target volumes which might either be smaller like partial breast irradiation for low risk patients or quite more extended like comprehensive locoregional irradiation including the internal mammary lymph nodes for patients with adverse risk factors. At the same time, dose prescription will follow the outcome of prospective clinical trials with hypofractionation with daily doses below 3 Gy already widely introduced in daily clinical practice and with higher daily doses or dose variation over the target volumes depending on the risk of recurrences being investigated. This can only go hand in hand with a continuing improvement of treatment delivery with a more homogeneous dose distribution overall and if indicated an intended dose variation like in the simultaneous integrated boost technique for high risk volumes. For all of this, an optimal interdisciplinary collaboration between researchers, radiation oncologists, medical physicists and radiation therapists is obviously indispensable.

Teaching Lecture: Evaluating toxicity of new targeted drugs

SP-0199
Evaluating the toxicity of new targeted drugs in combination with radiotherapy
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The aim of this lecture is to provide the practicing radiation oncologist with an overview of radiotherapy practice in the era of molecularly targeted agents, focusing on issues of safety and toxicity when these modalities are delivered concurrently or in interdigitated fashion.
As more targeted agents are approved for the treatment of metastatic cancers, the challenge of managing these combinations in the palliative and oligometastatic settings, where the use of standard low- and SBRT dose range prescriptions are employed, respectively, is becoming increasingly common. An overview of available clinical data will be provided for classes of agents in common use, including inhibitors of the EGFR, VEGF and mTOR axes. Immunomodulatory agents and PARP inhibitors will also be discussed.
Design of clinical trials to evaluate combinations of targeted agents with radiotherapy also presents unique challenges. Issues regarding endpoint selection and DLT definition will be explored using data and illustrative examples. Alternative approaches of capturing toxicity data, e.g. from population databases will also be discussed.

Teaching Lecture: QA and commissioning of brachytherapy treatment planning systems

SP-0200
QA and commissioning of brachytherapy treatment planning systems
A. Carlsson Tedgren[1]
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Quality assurance and commissioning of brachytherapy treatment planning systems (TPS) comprise among other tasks verification of single and multiple source isodose distributions, applicator reconstruction, electronic data transfer, optimization software and dose volume histogram calculations. Comparison of TPS derived plans against a second TPS is valuable as is end-to-end dose measurements of plan delivery. While output by dose calculation engines based on the TG43 formalism is easy to verify, the task is more complex for the recently introduced model based dose calculations algorithms (MBDCA). The American Association of Physicists in Medicine (AAPM) has initiated a "Working Group on Model-Based Dose Calculation Algorithms in Brachytherapy" to derive and distribute well defined test plans and recommendations for commissioning MBDCAs. This lecture will cover existing recommendations for commissioning radiotherapy and in particular brachytherapy TPS, provide practical examples of the process and an update on the ongoing work to derive and distribute test plans for commissioning MBDCAs.

Teaching Lecture: Review of (low dose) radiotherapy for benign disease

SP-0201
Review of (low dose) radiotherapy for benign disease
H. Seegenschmiedt[1]
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Abstract not received.

Symposium with Proffered Papers: Lung - treatment intensification and individualisation I

SP-0202
Pulmonary toxicity
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Purpose: Radiation induced pulmonary toxicity after radical radiotherapy or chemoradiation is difficult to score in lung cancer patients because tumor progression and exacerbation of preexisting pulmonary co-morbidities may have similar clinical characteristics. This presentation discusses several aspects of pulmonary toxicity.
A mild dry cough is common during the acute phase of lung irradiation. Radiation Pneumonitis (RP) is characterized by dyspnea, unproductive cough and occasionally mild fever, and typically presents between 1-6 months after treatment. Severe late lung complications, like pulmonary fibrosis,